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The Revelation Effect in Autobiographical Memory

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The Revelation Effect in Autobiographical Memory
by

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Table of Contents

List of Figures

List of Tables

Abstract

The revelation effect is a memory illusion in recognition memory where items are more likely to be considered old if they are immediately preceded by a cognitive task (for a review, see Abfalg, Bernstein, & Hockley, 2017). Recent research has shown that the revelation effect appears in past and future episodic judgments so long as the tasks are autobiographical in nature (Westerman, Miller, & Lloyd, 2017). Aging is a factor that has not yet been studied in the revelation effect literature in terms of autobiographical memory. It has implications because of aging's significant impact on mental time travel. During this experiment, young adults and older adults rated life events based on if those events had occurred in their childhoods or would occur within the next ten years. Half of the life events were preceded by a revelation task (an anagram). Object and spatial imagery skills were measured at the end of each session. Revelation effects did not differ with age. Object and spatial imagery were correlated, consistent with past findings, and object imagery predicted the revelation effect in an age-dependent manner: as object imagery increased, the revelation effect decreased in older adults but increased in young adults. Young adults also gave greater ratings overall while older adults were more conservative. These ratings may reflect both object imagery abilities as well as age-related cognitive decline. Overall, the results support the ones by Thapar & Sniezek (2008) in that they challenge both the original claim that older adults are not susceptible to the revelation effect (Prull et al., 1998), as well as the consensus that aging is associated with higher vulnerability across memory illusions. The findings also highlight the importance of exploring object imagery's role in aging and autobiographical tasks.

Keywords: the revelation effect, illusions, aging, false memory, visual imagery, memory

Introduction

French philosopher René Descartes posited that knowing that one can think is the only reliable proof of existence. In other words, the senses are not as reliable because they are easily deceived. One major way that the senses can be tricked is by illusions, which have fascinated academics for ages. The contrast between perceived reality and actual reality of events has historically been an interest deeply rooted in multiple subjects such as psychology, philosophy, and physics (Roediger, 1996). However, academic enthusiasm for different kinds of illusions developed at different paces. In psychology for example, the scientific study of memory illusions was traditionally shunned. This prevailing view underwent a major shift in the 1960's-1970's, when Ulric Neisser's "Cognitive Psychology" breathed life into the subject. This milestone work inspired a wave of memory studies that were conducted for the sake of studying memory errors themselves. From there, the study of false memories took off (for a review, see Roediger, 1996).

An important note about memory distortions today is that scientific interest in the topic is expansive and not limited to cognitive psychology (Schacter, 1995). The memory distortion literature benefits from several levels of analysis including biology, neuroscience, sociology, and history. Despite this, specifically in cognitive psychology, certain memory distortions remain in great need of research that can further explore their generality, limits, and other characteristics. One example of this is a memory illusion called "the revelation effect," a memory illusion tested in the current study. Specifically, during this study, young adults and older adults rated life events based on whether those events had occurred in their childhoods or would occur to them within the next ten years. Half of the life events appeared in a task condition, where anagrams preceded the life events, while the other half of the life events appeared in the control condition, where no anagrams were used. Imagery construct abilities were measured at the end of each session. Overall, the present study explores the revelation effect under a paradigm that involves

past and future thinking, aging, and imagery constructs. Each of these will be reviewed before discussing the current study.

Past and Future Thinking

Mental time travel refers to the human ability to vividly experience events in the past and future (Tulving, 1983). It operates on episodic memory, which is the memory for context-embedded events from the past (Balota, Dolan, & Duchek, 2000). Past thinking consists of recall. Future thinking has been summed up by the constructive episodic simulation hypothesis (Schacter & Addis, 2008), which states that imagining future events requires pulling from the past. Elements from prior experience can be reorganized in different ways that allow one to efficiently simulate the future. The view that past and future thinking engage the same cognitive processes is heavily supported by both experimental and neural evidence (Addis et al., 2009; D'argembeau & Van der Linden, 2004; El Haj, Antoine, & Kapogiannis, 2015; Hassabis et al., 2007; Juskenaite et al., 2014; Okuda et al., 2003; Szpunar et al., 2007).

One study (Szpunar et al., 2007) has analyzed the extent to which personal events, as opposed to public events, activate neural regions. This study instructed participants to think about personal episodes and included a condition where participants had to imagine events surrounding public figures (e.g. Bill Clinton). The bilateral frontopolar cortex and the medial temporal lobe activated for both past and future thinking, replicating past findings. The more significant finding though was that these regions had weak activations for the public figure condition, which suggests that the similar past/future neural correlates are specific to personal, autobiographical events. These neural regions consistently show higher activations during future thinking, which is a result of past thinking only using recall, while future thinking requires both

recall and the flexible recombination of prior events (Schacter, Addis, & Buckner, 2007). Together, the neural data shows that future thinking is dependent on past thinking, and that both engage the same core brain network so long as episodic memory is autobiographical in nature. This network remains the same with age, too: healthy older adults activate the same core brain network for past and future autobiographical thinking as young adults (Schacter, Gaesser, & Addis, 2013). This finding is important because it is in line with many studies that have established that there is a special relationship between memory and aging.

Aging

The general interaction between aging and memory can be summed up with the term "cognitive slowing" (Welford, 1958), which is the global slowing of cognitive processes with age that is widely documented across memory and other cognitive tasks (Salthouse, 1996). Cognitive slowing is a result of natural aging, so it occurs regardless of cognitive impairments (Ballesteros, Mayas, & Reales, 2013). One other account on why memory decreases with age is the theory of reduced processing resources, which is based on the fact that tasks deplete attentional capacity for cognitive resources (Balota et al., 2000). This theory states that the pool of attentional capacity lessens with age, which puts older adults at a disadvantage because they then tend to avoid elaborate memory processes (Kahneman, 1973). In short, the inverse relationship between age and memory is clear: as age increases, memory decreases. This is generally the case, though exceptions do exist with memory types that require minimal attention. Examples include procedural memory (i.e. memory for common physical activities such as walking and biking) and semantic memory, or world knowledge such as colors, word definitions, and shapes (Balota et al., 2000).

Age has a clear impact on mental time travel as well: it more deeply inhibits mental time travel when it involves the future. Older adults tend to generate less details for future events than past events (Spreng & Levine, 2006). A more recent study has shown that older adults perform worse during both future mental time travel as well as future self-reference (i.e. pinpointing whether events have happened in the past or future in reference to a future date) compared to young adults (Anelli et al., 2016). This deficiency extends to atemporal events: older adults perform worse when imagining future events compared to imagining events where time does not matter (Rendell et al., 2012). The greater weakness for future thinking in older adults may have to do with the fact that recombining past events to simulate future ones is more cognitively demanding than simply recalling past events or conceptualizing atemporal ones. All in all, aging inhibits both past and future thinking, but future thinking to a greater extent. It is important to note, though, that aging plays an interesting role in not only autobiographical past and future thinking, but also in memory illusions.

Broadly, the interaction between age and memory illusions is predictable. A great deal of literature suggests that age increases vulnerability to memory illusions. Older adults fall more for repeated lures, the false facial recognition paradigm, the Deese-Roediger-McDermott paradigm, and the misinformation effect (Dodson & Schacter, 2002; Edmonds et al., 2012; Gallo, 2010; Wylie et al., 2014). Despite this, the effect of age on memory illusions is not one-sided. For example, no significant age-related differences were detected in testing a type of memory illusion called the revelation effect (Thapar & Sniezek, 2008). This finding is one of the motivations for the current study.

The Revelation Effect

The revelation effect is a tendency towards a more liberal response bias in item recognition (i.e. more likely to consider an item "old") if that item is immediately preceded by a cognitive task. For example, when someone solves an unrelated addition problem right before judging whether a test item is new or old, they are more likely to judge the item as "old," or already studied, compared to participants who did not perform a task (Niewiadomski & Hockley, 2001). Across studies though, there are a couple hypotheses for the revelation effect that have gathered a great amount of support over the years (Abfalg et al., 2017). One hypothesis that remains popular today is the discrepancy-attribution hypothesis. This is based on fluency and familiarity, with fluency being defined as the ease with which a stimulus can be processed (Alter & Oppenheimer, 2009). Low fluency means high mental effort and high fluency means low mental effort. The discrepancy-attribution hypothesis states that there can be a discrepancy between low initial fluency (i.e. from the cognitive task preceding the test item) and high actual fluency (i.e. from the simple test item). A feeling of familiarity occurs when this discrepancy is attributed, sometimes falsely, to previous experience (Whittlesea & Williams, 1998).

In more detail, revelation tasks that precede stimuli are manipulations of fluency. A core part of the hypothesis is that revelation tasks take time (high mental effort, lower fluency) as opposed to simply viewing the test items that follow (low mental effort, high fluency). Following the hypothesis, this discrepancy between low initial fluency and high actual fluency is then attributed to familiarity.

The revelation effect has been studied through the lens of aging, but only twice. The first instance (Prull et al., 1998) involved two experiments. Their first experiment used degraded stimuli that were slowly revealed by proportion of pixels shown, and a revelation effect appeared in young, but not older, adults. Their second experiment was similar but involved longer

presentation times for the older adult group to account for cognitive slowing. Nevertheless, the findings were the same. The second instance came a decade later in a follow-up study (Thapar & Sniezek, 2008) motivated by the fact that it is unusual to find memory illusions that young adults are more vulnerable to than older adults. The goal of their study was to check if the findings by Prull et al. (1998) generalized to other revelation tasks. So, they used word fragments (that slowly revealed words letter by letter) and anagrams instead of perceptually degraded stimuli. A statistically equivalent revelation effect was found for both younger and older adults in both tasks, challenging the previous claim that older adults are unaffected by revelation tasks. This led the authors to conclude that their different findings were the result of methodological differences, and that future research is needed to clarify the boundary conditions of aging's impact. One variable relevant to the current study where the boundary conditions of aging are more defined is visual imagery.

Imagery Constructs

Visual imagery is crucial for imagining events. Given that, it is strongly tied to the efficiency of autobiographical recall (Rubin & Umanath, 2015; Williams, Healy, & Ellis, 1999). However, the way it is tied to autobiographical recall has not always been consistent, with conflicting findings suggesting that individual differences in visual imagery creation have varying effects on autobiographical memory (D'Argembeau & Van der Linden, 2006; Greenberg & Knowlton, 2014). This inconsistency has been attributed to the fact that visual imagery is typically treated as a single entity when it should really be broken down further to account for such individual differences. Specifically, visual imagery can be split into two distinct parts: object imagery and spatial imagery. Object imagers prefer rich, pictorial images and tend to be more skilled at identifying image details, while spatial imagers prefer abstract representations

(e.g. charts) and tend to be more skilled with mental transformations and rotations (Vanucci & Mazzoni, 2009). Recently, these two preferences were taken into account under a past and future autobiographical thinking paradigm for the very first time, and what was found was that object imagery is associated with better future details compared to spatial imagers for past events only, while spatial imagery was associated with better episodic specificity for past and future events compared to object imagers (Aydin, 2018). The power of spatial imagery over both past and future thinking may be a result of a certain level of spatial awareness being necessary for imagining any higher-level details that are above just the physical features of an event (Sheldon et al., 2016).

Visual imagery has been shown to decline with age. This decline is two-fold: there is a drop in speed and accuracy, and this is present in both types of visual imagery (Kemps & Newson, 2005; Palmermo et al., 2016). The latter found a significantly greater deficit in the mental rotation tasks, which suggests that spatial imagery skills diminish more over time. These studies lend support to the view that imagery constructive efficiency (especially spatial imagery) is not preserved with age, which is relevant to the current study.

The Current Study

The goal of the present study was to test the impact of aging on past and future autobiographical thinking by using the revelation effect. The participant pool consisted of two groups: young adults and older adults. Participants were split into either a past or future condition. Then, participants in the past condition were asked whether life events had happened to them in their childhood, while participants in the future condition were asked whether life events would happen to them within the next ten years. Participants in the task condition solved anagrams prior to each life event question (with the anagram being a word in that question),

while participants in the control condition received the questions without any preceding tasks. At the end of each experiment, participants were measured on their imagery construction skills through the Object-Spatial Imagery Questionnaire, or OSIQ (Blajenkova, Kozevnikhov, & Motes, 2006). Visual imagery ability was not measured. The current study focused on three main outcomes.

The first goal was to replicate the findings in Experiment 2 of the study by Westerman, Miller, and Lloyd (2017) regarding the revelation effect in autobiographical memory specifically. This is a recent study that used the revelation effect to study past and future autobiographical thinking, and the main study that the current one is based upon. It consisted of six experiments where participants made judgments on whether life events from the Life Events Inventory (Fields & Brown, 2015) had happened to them in the past or might happen to them in the future. All six experiments used related and non-related anagrams that preceded each life event question. Experiments 1-2 consisted of simply this, with the first experiment using anagrams of words in the life event questions and the second experiment using non-matching anagrams. Significant revelation effects were found in both. This meant that preceding a recognition judgment with a simple cognitive task, regardless of the relevance of the task to the question, made a participant more likely to believe that a life event had already happened in their past or would occur in their future. Experiments 3-4 consisted of semantic wording instead, with the life event questions asking about people in general rather than the participants themselves, but these experiments produced no significant effects. Experiment 5 used pleasantness ratings of the life events because past studies that did find significant revelation effects with semantic questioning involved such ratings. However, no revelation effect was found. Finally, in Experiment 6, participants were asked to answer the life event questions from the point of view

of a close friend and the revelation effect reappeared. Overall, completing simple cognitive tasks prior to autobiographical event judgments and memory judgments from the perspective of a friend made participants more likely to believe something had happened in the past or would happen in the future. This was interpreted to be a result of participants approaching questions from the perspective of a friend similarly to how they would approach questions about themselves, regardless of the nature of the question (Westerman et al., 2017). For this study, because it is based off Experiment 2 and it uses the same revelation task and paradigm, we hypothesize that we will find revelation effects during revelation conditions.

The second main goal of the current study was to explore aging, which had not been investigated in the revelation effect literature under the context of autobiographical memory. This was accounted for by using both young adults and older adults under the design of Experiment 1 from Westerman et al. (2017). This study tested whether the boundary effects from Experiment 1 change in older age. One key interaction that was expected to have the most significant effect was older adults during the future condition and the revelation condition: this should result in the highest amount of "yes" responses because their weakness in future thinking combined with the revelation effect should raise "yes" responses the most. Overall, we hypothesized that revelation effects would be higher for older adults with the highest effect being in that triple interaction.

The third main goal was to find any relationships involving visual imagery. Visual imagery, as measured by the OSIQ, had not been studied with the revelation effect before. However, it was recently studied under the paradigm of past and future thinking. This was relevant because that study found that object imagery affects the sensory details of past events, while spatial imagery affects the episodic specificity of both past events and future thinking

(Aydin, 2018). Given this, we hypothesized that visual imagery might increase resistance to the revelation effect, with distinct effects that are dependent on the individual. Object imagers should be less vulnerable to the revelation effect during the past condition, while spatial imagers should be less vulnerable to the revelation effect overall. So, we hypothesize that imagery performance may moderate the effects of aging in a positive way.

Methods

Participants

Participants consisted of 82 undergraduate students (67 female, 15 male) from Seton Hall University and 100 older adults, individuals who were 60+ years old, recruited by Qualtrics. According to our a priori power analysis using the results of Westerman et al. (2017), 42 older adults and 42 young adults were needed to achieve a power of 0.8, for detecting a revelation effect assuming the same effect size as previously reported.

Materials

The events used were 60 events from the Life Event Inventory (Fields & Brown, 2015), which consists of likely autobiographical events such as "found a lost wallet." We used a modified version so that all life events would be relevant for older adults thinking about the future (e.g. changed "accidentally fell asleep during class and had the teacher wake you up" to "accidentally fell asleep and had someone wake you up"). Imagery construct abilities were measured by the OSIQ, which asks for ratings on object imagery and spatial imagery questions on a scale of 1-5 (1 = totally disagree, 5 = totally agree). This questionnaire has internal reliability, convergent validity, and divergent reliability (Blajenkova et al., 2006): ratings for object imagery preferences and experiences were significantly correlated with object, but not spatial, scores. Meanwhile, ratings for spatial imagery preferences and experiences were

significantly correlated with spatial, but not object, scores. There is also test-retest reliability (i.e. those findings were repeated with new participants twice more in the same study, with a one week separation between the additional tests) and ecological validity (i.e. visual artists had greater object imagery scores than scientists, while scientists had greater spatial imagery scores than visual artists).

Design and Procedure

This experiment was a 2 (age: young adult or older adult) x 2 (time: past or future) x 2 (condition: revelation effect or control) mixed-factor design with condition manipulated within participants and time and age manipulated between groups. The dependent measures were the revealed and control scores. Revealed scores were likelihood judgments about events preceded by anagrams, while control scores were likelihood judgments about events not preceded by anagrams.

Participants were randomly assigned into a past or future condition with sixty randomly ordered trials. The past condition involved participants being asked if certain events happened to them before the age of thirteen. The future condition involved participants being asked if certain events would happen to them within the next ten years. Responses were based on a scale of likelihood from 1-8 (with 1 meaning "definitely did not happen" and 8 meaning "definitely will happen"). There were sixty events total, which were taken from the Life Events Inventory (Fields & Brown, 2015). These were counterbalanced so each event was equally likely to appear in the past or future condition. All screens in this study were untimed, so participants spent as long as they needed on each screen. During the task condition, anagrams were shown before each event. The anagram solutions were words not in the events. Each anagram was eight letters long. Life

events appeared in the center of the screen, with anagrams preceding them and the rules for those anagrams appearing underneath on the same screen. Every word followed the same rule and participants were introduced to these rules prior. An example of the anagram rule was the anagram "C R O E M E V O " having the rule "5 4 6 8 7 3 2 1 ," hinting that the anagram can be solved by typing the letters in that order. Typing the word correctly and pressing "enter" resulted in a new screen with the life event and a likelihood scale. The control condition simply consisted of the life event and the scale appearing simultaneously. At the end of each experiment, participants answered the OSIQ (Blajenkova, Kozevnikhov, & Motes, 2006). This was a 30-item test where participants responded to items distinguishing object and spatial imagery use through a 5-point scale based on level of usage.

Results

We conducted a 2 (revelation effect) by 2 (age: young adult or older adult) by 2 (time: past or future) repeated measures ANOVA. Means for the conditions are presented in Table 1. For within-subject effects (age and time) there was a main effect of trial type demonstrating a revelation effect, $F(1, 178) = 8.62$, $p = 0.004$, $\eta_p^2 = 0.046$, as participants gave higher ratings to revealed ($M = 4.502$, $SD = 1.125$) than control trials ($M = 4.341$, $SD = 1.081$, $d = 0.214$). There was no main effect of time ($p = 0.309$, $\eta_p^2 = 0.006$) and there was no significant interaction between age and time ($p = 0.238$, $\eta_p^2 = 0.008$). There was a significant main effect of age, $F(1, 178) = 70.37$, $p < 0.001$, $\eta_p^2 = 0.283$, because collapsing across the revealed and control conditions younger adults gave higher ratings ($M = 5.089$, $SD = 0.951$) than older adults ($M = 3.754$, $SD = 1.255$, $d = 0.622$). Thus, overall, younger adults were more likely to say that the life events would happen to them in the future or did happen in the past. In other words, young adults

gave greater likelihood judgments in general. The three-way interaction was not significant, p = 0.3, η_p^2 = 0.006.

Table 1

Table of Means

	Control	Revealed	Rev. Effect	Object/Spatial
YA: Past	5.15	5.38	0.22	3.47/2.74
	SD = 0.808	SD = 0.953	SD = 0.626	SD = 0.551, 0.599
	CI = 4.905, 5.400	CI = 5.08, 5.67	CI = 0.156, 0.293	CI = 3.641, 3.304; 2.822, 2.556
YA: Future	4.82	5.00	0.18	3.58/2.78
	SD = 1.023	SD = 1.02	SD = 0.787	SD = 0.593, 0.555
	CI = 4.511, 5.137	CI = 4.691, 5.315	CI = 0.124, 0.234	CI = 3.762, 3.398; 2.946, 2.606
OA: Past	3.73	3.76	0.03	3.20/2.37
	SD = 1.265	SD = 1.269	SD = 0.214	SD = 0.846, 0.796
	CI = 3.375, 4.08	CI = 3.404, 4.108	CI = 0.022, 0.038	CI = 2.945, 3.433; 2.144, 2.586
OA: Future	3.66	3.87	0.21	3.06/2.30
	SD = 01.228	SD = 1.259	SD = 0.664	SD = 0.895, 0.704
	CI = 3.320, 4.000	CI = 3.525, 4.222	CI = 0.615, 1.088	CI = 2.816, 3.312; 2.107, 2.497

Table 1. Table of means for all conditions, likelihood ratings, and visual imagery scores. The effect sizes for the revelation effect were d = 0.108 (young vs. old), d = 0.063 (young: past vs. young: future), and d = -0.241 (old: past vs. old: future). The revelation effect values were calculated by subtracting control means from revealed means.

Two regression equations were run (one for each age) using the object and spatial imagery scores as the predictor variables and the revelation effect as the outcome variable. The revelation effect

was represented as the difference between the revealed and controls. The young adult group passed assumptions of equality of variance, normality of variance, and linearity. There were no influential cases except for one case (D = 0.118), but it was not high enough to warrant omission from the analysis. In term of visual imagery, object imagery, t = 2.131, p = 0.036, β = 0.239, B = 0.296, CI = 0.020, 0.571, was a significant positive predictor of the revelation effect in young adults as shown in Fig. 2. Spatial imagery, t = -1.727, p = 0.088, β = -0.194, B = -0.238, CI = -0.513, 0.036, was not. As object scores increased, the revelation effect increased. The older adult group passed assumptions of equality of variance, normality of variance, and linearity as well, though there was a slight negative skew for normality. There were no influential cases except for one (D = 0.107), which was also not high enough to warrant omission from the analysis. But in older adults, object ability, t = -3.178, p = 0.002, β = -0.337, B = -0.297, CI = -0.482, -0.111, was a significant negative predictor of the revelation effectas shown in Fig. 3. As object scores increased, the revelation effect decreased. Spatial imagery, t = 1.854, p = 0.067, β = 0.197, B = 0.201, CI = -0.014, 0.416, did not predict the revelation effect here either. These results are represented as scatterplots in Fig. 1.

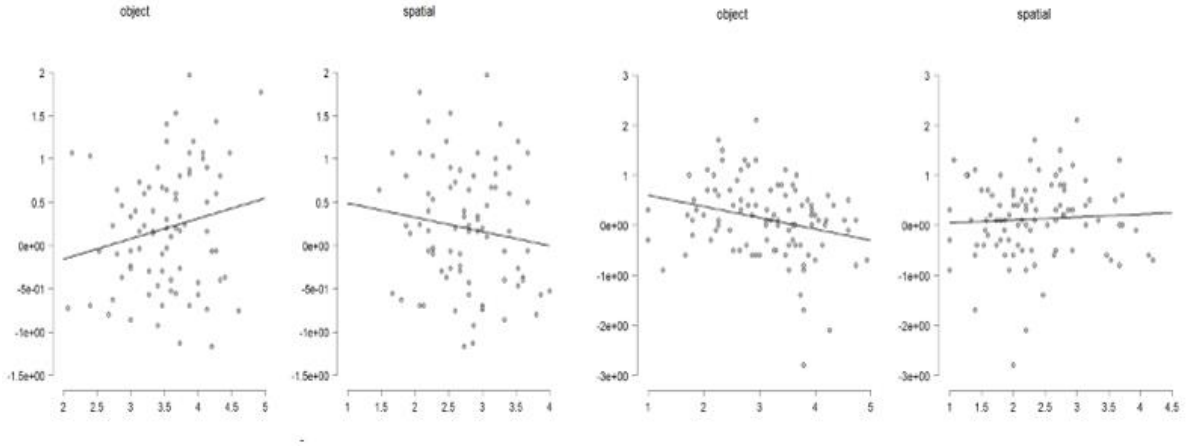

Figure 1. Scatterplots for young adults (leftmost two) and older adults (rightmost two) in terms of visual imagery scores and the revelation effect. Y-axes indicate the revelation effect and X-axes indicate visual imagery scores.

Visual imagery scores were also correlated. In young adults, object and spatial scores, $r = 0.253$, $p = 0.022$, were associated with each other. In older adults, object and spatial scores, $r = 0.416$, $p = <0.01$, were strongly correlated with each other.

Discussion

Overall, the research here is consistent with Westerman et al. (2017) and our hypothesis based on using a paradigm from their Experiment 2 in that participants showed revelation effects in past and future conditions whenever anagrams were present in an autobiographical past and future thinking paradigm. The lack of a time and age interaction is surprising, though. We hypothesized that older adults would be most vulnerable to the revelation effect in the future condition specifically, given their track record of weak future thinking when compared with their past thinking (Anelli et al, 2016; Rendell et al., 2012; Spreng & Levine, 2006). Instead, we found that there were no significant age differences for the revelation effect. These findings are consistent with Thapar & Sniezek (2008) in that both age groups were susceptible to the revelation effect but that there was no age difference (although we noted that, numerically, the revelation effect was smaller in older adults in the past condition).

The second contribution to this study is the relationship between memory illusions and visual imagery. First, we observed a correlation between object and spatial imagery: object and spatial scores were associated with each other in young adults and strongly correlated with each other in older adults. This is in line with findings from Kozhevnikov, Kosslyn, & Shepard (2005), which found that visual imagers are associated with lower spatial imagery scores and

vice-versa. Second, there was an age-dependent correlation of object imagery with the revelation effect: in young adults, the revelation effect increased as object imagery increased. In older adults, the revelation effect decreased as object imagery increased. There have been no previous comparisons of the revelation effect and visual imagery types, so what we hypothesized based on recent results from Aydin (2018) was that greater visual imagery scores in either type should protect against the revelation effect. The logic was that high visual imagery in that study showed positive effects on the efficiency of both past and future thinking. However, the results from the current study suggest that the two types of visual imagery influence the revelation effect differentially. It is not too surprising that spatial imagery plays a less important role given that there are no spatial imagery elements in the study (e.g. mental rotations, charts, maps). The types of imaginary scenarios the autobiographical life events depict call more upon object imagery (e.g. colors, shapes, objects, people). What is surprising, though, is that high object imagery scores only protected against the revelation effect in older adults.

But why is the correlation in two directions? The finding in young adults, that object imagery increased vulnerability to the revelation effect, was unexpected at first because we hypothesized that better imagery for the life events would mean less susceptibility to memory illusions involving them. A potential explanation for this requires thinking more deeply about the revelation effect, specifically the judgment attribution phase of the discrepancy-attribution hypothesis. It is possible that the discrepancy between solving the hard revelation task and answering the easy life event item is more pronounced in young adults because of their higher object imagery abilities, which would make thinking about autobiographical life event items easier. Thus, there would be a more pronounced discrepancy between the low fluency anagram

and the high fluency test item, which would result in greater false attribution judgments to the test item. This would create a larger revelation effect.

One way to explain why higher object imagery has the opposite effect in older adults (i.e. lower revelation effect) is that due to age-related cognitive decline, older adults might be less likely to detect discrepancies in the first place. This would decrease the revelation effect overall. Additionally, the lowered revelation effect in older adults can be attributed to stereotype threat. Stereotype threat is a phenomenon where one is concerned that they might give into stereotypes about a group they belong to, so they change their performance in response (Steele, 1997). Prevalent stereotypes of older adults include memory loss (e.g. gaps in memory being jokingly referred to as "senior moments") and cognitive decline. Often, stereotype threats in experimental situations need to be elicited or prompted. However, with older adults, simply taking a test involving memory is enough to create self-inflicted stereotype threat. This is because older adults, more so than other age groups, are especially concerned with their own abilities so they are less attentive to external stereotypes but more sensitive to internal, "self-concept" stereotypes (for a review, see Barber, 2017). Stereotype threat may very well be playing a role due to the obvious memory focus of the life event questions. We suspect that the way that older adults might be responding to this could be with conservative likelihood judgments. This would counteract any discrepancies that they do detect. This explanation is consistent with their overall likelihood judgments in both revealed and control conditions, which were lower than the young adult ratings across the board.

In general, young adults gave greater judgments while older adults were more conservative. The takeaway from the young adult means is that even though an object imagery effect in young adults was not seen in the revelation effect, it was shown in the ratings. It is

possible that young adults visualize life events more clearly and this positively affected likelihood ratings, which would explain why their likelihood judgments were higher on average across the board (in terms of revealed vs. control). On the other hand, the takeaway from the older adult means is that even though the lower ratings might reflect their lesser object ability, it might also be a reflection of stereotype threat (i.e. more conservative judgments) as well as memory decline in general (i.e. not detecting discrepancies) due to both the theory of reduced processing resources (Balota et al., 2000; Kahneman, 1973) and cognitive slowing (Welford, 1958), which has been widely documented in the psychology literature (Salthouse, 1996).

Future Directions

One future research direction in terms of how the two types of visual imagery interact with the revelation effect is to use a spatial-based paradigm instead of an object-based one. This is because the findings that only object imagery played a role in the current study can be attributed to the fact that the paradigm emphasized autobiographical events, which only called upon object imagery skill. Based on our results, if a future paradigm used tasks like mental rotations instead of autobiographical events, only spatial imagery would play a role. It is important to note that spatial imagery was not that far from significance in terms of predicting the revelation effect in the current study, and its trend was the opposite of object imagery's in both age groups. The role of spatial imagery in this context could further be explored with aging to discover if spatial imagery, like object imagery, predicts the revelation effect in an age-dependent way. On the topic of aging, this study is just the third to compare the revelation effect in young and older adults. Future studies should continue to take aging into consideration to check if the revelation effect truly is a unique memory illusion in the sense that, while it does

appear in both young and older adults, it does not seem to affect older adults significantly more as is standard for memory illusions.

To conclude, the take-home point of this study is two-fold. First, that object imagery predicts the revelation effect in an age-dependent way in an autobiographical-based paradigm. Secondly, that the revelation effect appears in both young and older adults but does not affect them significantly differently. Using a spatial-based paradigm while continuing to monitor for age differences would be the next logical step in expanding the revelation effect literature.

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